

Special Documentation

Micropilot FMR20B, FMR30B

Application package
Heartbeat Verification
HART



1 About this document

1.1 Document function

This manual is a Special Documentation and does not replace the Operating Instructions included in the scope of supply. It is a part of the Operating Instructions and serves as a reference for using the Heartbeat Technology function integrated in the measuring device.

1.2 Content and scope

This document contains descriptions of the additional parameters and technical data of the application package and detailed explanations regarding:

- Application-specific parameters
- Advanced technical specifications

1.3 Symbols

1.3.1 Safety symbols

CAUTION

This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.

DANGER

This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.

NOTICE

This symbol contains information on procedures and other facts which do not result in personal injury.

WARNING

This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.

1.3.2 Symbols for certain types of information and graphics

Tip

Indicates additional information

Reference to another section

1, 2, 3. Series of steps

1, 2, 3, ...

Item numbers

Bluetooth

Wireless data transmission between devices over a short distance.

1.4 Documentation



For an overview of the scope of the associated Technical Documentation, refer to the following:

- *Device Viewer* (www.endress.com/deviceviewer): Enter the serial number from the nameplate
- *Endress+Hauser Operations app*: Enter serial number from nameplate or scan matrix code on nameplate.

1.5 Registered trademarks

HART®

Registered trademark of the FieldComm Group, Austin, Texas, USA

Bluetooth®

The *Bluetooth*® word mark and logos are registered trademarks owned by the Bluetooth SIG, Inc. and any use of such marks by Endress+Hauser is under license. Other trademarks and trade names are those of their respective owners.

2 Product features and availability

2.1 Product features

The Heartbeat Verification application package offers diagnostic functionality by means of continuous self-monitoring as well as in situ verification of devices in the application.

The test scope achieved using these diagnostic and verification tests is expressed as the **total test coverage** (TTC). The TTC is calculated using the following formula for random errors (calculation based on FMEDA as per IEC 61508):

$$TTC = (\lambda_{TOT} - \lambda_{du}) / \lambda_{TOT}$$

λ_{TOT} : Rate of all theoretically possible failures

λ_{du} : Rate of undetected dangerous failures

The undetected dangerous failures are not diagnosed by the device diagnostics. If these failures occur, they can falsify the measured value that is displayed or interrupt the output of measured values.

Heartbeat Technology confirms that the device is functioning within the specified measuring tolerance with a defined TTC.

The TTC is at least 95 %.



The current value for the TTC depends on the configuration and integration of the measuring instrument. It is determined under the following basic conditions:

- Integration of measuring instrument for measured value output via 4 to 20 mA HART output
- **Simulation** parameter **Off** option
- **Failure behavior current output** parameter set to the **Min.** option or **Max.** option and evaluation unit detects both alarms
- Settings for diagnostic behavior correspond to factory settings

2.2 Availability

You can order the Heartbeat Verification application package either together with the device or at a later stage with order code XM35ACL. More information on the order code is available from the website www.endress.com or from an Endress+Hauser sales organization.

The availability of the application package can be checked as follows:

- Order code with breakdown of the device features on the delivery note
- On the web using the Device Viewer: enter the serial number from the nameplate and check whether the order code is displayed
- In the operating menu: here you can see if the application package is enabled.
Navigation: System → Software configuration → Software option overview

2.2.1 Activation code

If ordered at a later date, a conversion kit will be supplied. This includes a tag with modified device data and an activation code.

Enter the activation code in the operating menu:

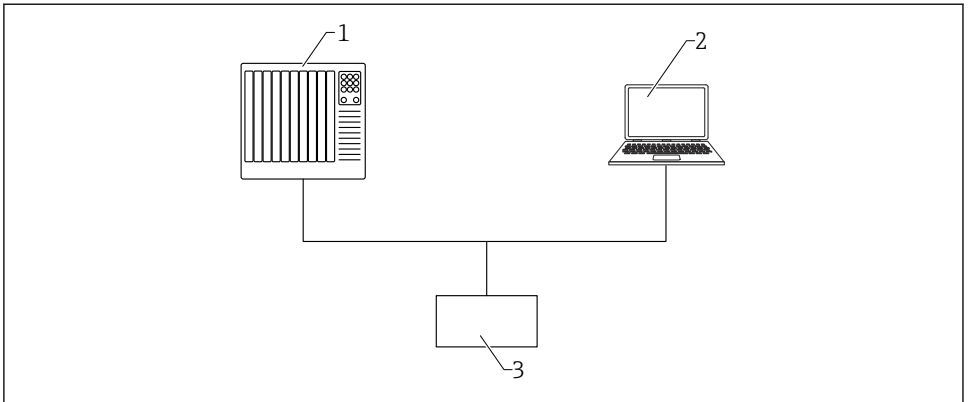
Navigation: System → Software configuration → Activate SW option

2.2.2 Access

Heartbeat Technology is compatible with all the system integration options. Interfaces with digital communication are required to access the data saved in the device. The speed of data transmission depends on the type of communication interface used.

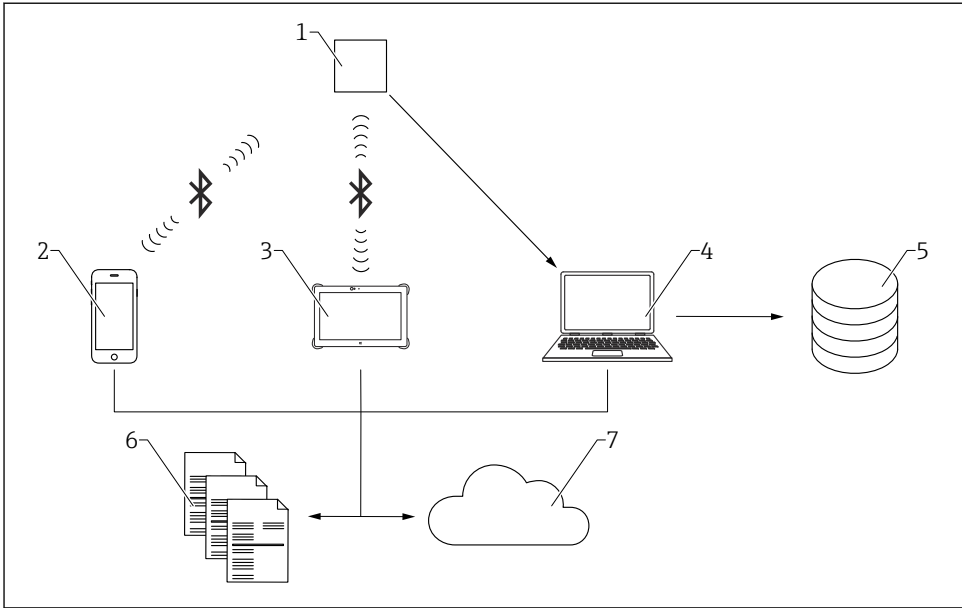
3 System integration

The functions of Heartbeat Technology are accessible through digital interfaces and can be used both via an asset management system and via the automation infrastructure (e.g. PLC).



A0040019

- 1 PLC
- 2 Asset management system
- 3 Device



A0047321

- 1 Device
- 2 Mobile terminals with SmartBlue app
- 3 Field Xpert
- 4 DTM-based tools, e.g. FieldCare or DeviceCare ...
- 5 Data archive
- 6 Verification report
- 7 Netilion Library

Perform Heartbeat Verification using one of the following interfaces:

- System integration interface of a higher-level system
- Local display (FMR30B only)
- Bluetooth (optional)

External access to the device in order to start a verification and signal the verification result (**Passed** option or **Failed** option) must be performed by a higher-level system via a system integration interface. It is not possible to start the verification via an external status signal and relay the results to a higher-level system via the status output.

The detailed results of the verification are saved in the device and provided in the form of a verification report. The last result in each case is saved in the device.

Verification reports can be created using the Plant Asset Management Software FieldCare, DeviceCare, or the SmartBlue app and FieldXpert.

3.1 Data exchange performed by the user (asset management system)

Heartbeat Verification

- Start of verification
- Upload, archive and document the verification results including detailed results

3.2 Data management

The result of a verification is saved as a non-volatile parameter set in the measuring device memory. Previous data are overwritten by new Verification results; only the last result is saved.

3.2.1 Verification report

Printing the Verification report

The Verification report is output in PDF format.



Prerequisite: A verification has already been performed.

3.2.2 File management

Netilion Library

Heartbeat verification reports can be saved in Netilion with the Netilion Library (www.netilion.endress.com). They can be uploaded by notebook, smartphone or a Field Xpert tablet.

The verification reports are then:

- online
- automatically assigned to their digital twin
- easier to find
- always readily available

4 Heartbeat Verification

Heartbeat Verification is performed on demand and supplements permanent self-monitoring with additional checks. During verification, the system checks whether the device components comply with the factory specifications. Both the sensor and the electronics modules are included in the tests.

Heartbeat Verification confirms the device function within the specified measuring tolerance on demand with a total test coverage TTC (Total Test Coverage) in percent.

Heartbeat Verification meets the requirements for metrological traceability in accordance with ISO 9001:2015 Section 7.1.5.2).

The Heartbeat Verification test result **Passed** confirms that, for example, the level accuracy is ± 2 mm (0.08 in) under reference operating conditions within the measuring range of 6 600 mm (260 in) with a specified total test coverage of > 95 %.

The result of verification is either **Passed** or **Failed**. The verification data are stored in the device using the FIFO method (First In – First Out) and optionally archived using the asset management software FieldCare on a PC or in the Netilion Library. Based on this data, a verification report is generated automatically to ensure that traceable documentation of the verification results is available.

It is possible to manually record reference data relating to the operator and the location. These reference data appear on the verification report.

4.1 Device behavior and interpretation

- Result: **Passed**
All test results are within the specification.
- Result: **Failed**
One or more test results are **Out of specification (S)**.



Recommendations in the event of a verification with the verification result: Failed

If a verification returns the result **Failed**, repeat the verification. In doing so, follow the measures below:

- Create defined and stable process conditions in order to rule out process-specific influences as much as possible.
- Compare current process conditions with those of the previous verification to identify possible deviations.
- Take remedial measures based on the diagnostic information of the device.

The cause of the error can be narrowed down by identifying the test group that has a **Failed** verification.



Operation continues during the entire Heartbeat Verification.

4.2 Verification

Perform verification:

1. Navigation: Guidance → Heartbeat Technology → Heartbeat Verification → Heartbeat Configuration → Heartbeat Verification
2. Select the **Start verification** option.

Show status:

- ▶ Navigation: Diagnostics → Heartbeat Technology → Heartbeat Verification → Status

Show result:

- ▶ Navigation: Guidance → Heartbeat Technology → Heartbeat Verification → Verification result → Verification result




4.3 Verification results

Access to the verification results via:



- SmartBlue app
- DTM-based tools (e.g. FieldCare or DeviceCare)
- Field Xpert

4.3.1 Classification of results

Individual result:

-  **Failed**
At least one individual test in the test group was **Out of specification (S)**.
-  **Passed**
All individual tests in the test group complied with the specifications.
The result is **Passed** even if the result of an individual test is **Not done** and the result of all other tests is **Passed**.
-  **Not done**
No test has been performed for this test group. For example, because this parameter is not available or activated in the current device configuration.

Overall result:

-  **Failed**
At least one test group has **Failed**.
-  **Passed**
All verified test groups were within the specification.
The overall result is **Passed** even if the result of individual test groups is **Not done** and the result of all other tests is **Passed**.



Heartbeat Verification confirms on demand that the device is functioning within the specified measuring tolerance with a total test coverage (TTC) specified as a percentage.

4.4 Verification report

The results of the verification can be documented via DTM-based tools, the SmartBlue app or FieldXpert in a Verification report. Since the Verification results are automatically and uniquely identified with the Operating time, they are suitable for the traceable documentation of the verification of devices.

The following information is provided on each report page/section for unique identification:

- Serial number
- Device tag
- Operating time (Verification)

4.4.1 Verification report, section 1

Measuring point identification, presentation of the overall verification result and confirmation of completion:

- **Device information**

Information on the location, Device tag, Device name, Order code, Firmware version, Hardware version

- **Calibration / Configuration**

Information on device configuration such as Empty calibration, Full calibration, Medium type, media group, CRC device configuration, CRC linearization table

- **Verification information**

Operating time (Verification) and verification ID for the clear assignment of the Verification results. This aids the traceable documentation of the verification.

- **Verification result**

Overall result of the verification is **Passed** if all individual results are **Passed**.

4.4.2 Verification report, section 2

Details on the individual results for the following test groups:

- Device and verification information
- Test groups
 - Verification pre-condition
 - Mainboard module
 - Sensor module

4.4.3 Verification report, section 3

Details with values for the individual tests from section 2.

4.4.4 Verification report, section 4

Additional data and information that can influence the assessment of the measurement results or the appraisal of the process conditions:

- Process condition (at the time of verification)
- Device history
- Sensor history

4.5 Test criteria for the test objects

4.5.1 Verification pre-condition

System status

Checks active measurement device errors at diagnostical behavior "alarm". If an active error is detected, then verification will be performed but the overall result will always be "Failed".

4.5.2 Mainboard module

Terminal voltage

Checks whether the voltage at the supply terminals is within the specified limits. Exceeding the maximum terminal voltage can damage the device. If the supply voltage is permanently in

the maximum range, the useful life of the device can be reduced. If the terminal voltage falls below the minimum, the device can fail.

Terminal voltage value

The Terminal voltage currently applied is measured and compared with the limit values (Minimum terminal voltage and Maximum terminal voltage).

Limit values: 12 to 30 V

Output current

The Output current is continuously read back and compared with the configured current in accordance with the measured value.

Current deviation

Checks whether read-back current at the output matches the current set by the device.

Limit values: -0.5 to +0.5 mA

Software integrity

Checks whether the function blocks of the software are executed in the correct order. Checks whether certain events are currently present e.g. incrementing of the sequence counter in the mainboard is checked with each new measured value in the sensor module. If this is not the case, **Failed** is displayed.

RAM check

Checks the correct function of the RAM (Random Access Memory). If a RAM cell is defective, this is detected by the value read back from the RAM cell and **Failed** is displayed.

ROM check

Checks the correct function of the ROM memory (Read-Only-Memory). If the checksum of the tested program code range does not match, **Failed** is output.

4.5.3 Sensor module

Signal quality

The Relative echo amplitude is used for evaluation purposes.

"Signal quality" parameter

Shows the quality of the evaluated level signal.

- Strong (>10 dB)
- Medium (≤ 10 dB)
- Weak (≤ 5 dB)
- No signal (0 dB)

"Relative echo amplitude" parameter

Shows the relative amplitude (i.e. the distance to the evaluation curve) of the evaluated level signal.

Radar Accuracy Index (RAI)

The Radar Accuracy Index (RAI) evaluates the Micropilot reference accuracy. The test method to determine the RAI is based on the generation of a test signal via the high-frequency oscillator and the measurement of the signal using the sample oscillator.

"Radar Accuracy Index (RAI)" parameter

The Radar Accuracy Index (RAI) [ppm] is output as the relative deviation between two RAI measurements:

- Traceable measurement which was performed during production as part of device calibration
- Measurement which is performed in the application as part of Heartbeat Verification

Failed option is output if the relative RAI deviation exceeds or drops below the limit values.

Limit values: -200 to +200 ppm

Clock and analog path

To ensure correct measurement, a test signal is generated and evaluated via the normal measuring path (frequency and amplitude).

"Reference echo frequency" parameter

The frequency of the test signal is evaluated and compared with the limit values

Limit values: 990 000 to 1 010 000 Hz

"Reference echo amplitude" parameter

The amplitude of the test signal is evaluated and compared with the limit values

Limit values: device-specific

IF signal

The check of the intermediate frequency signal (IF signal) ensures the sensor electronics and the associated signal path are functioning correctly. The permitted range is defined by limit values for the amplitude and amplitude swing.

"Maximum value IF amplitude" parameter

Measured maximum value of the IF amplitude

Limit values: max. 65 525 digits

"Minimum value IF amplitude" parameter

Measured minimum value of the IF amplitude

Limit values: min. 10 digits

"IF amplitude span" parameter

Amplitude swing; difference between the maximum value for the IF amplitude and the minimum value for the IF amplitude

Limit values: min. 10 digits

Sensor integrity

Checks the function of the sensor (no event active).

Energy boundaries

Checks whether the energy states are within the limits.

Energy monitoring

Checks the energy balance on the sensor.

"Energy storage capacity" parameter

Checks if the measuring capacitors are within the valid range

Limit value: 500 to 3 000 μF

"Radar signal input strength" parameter

Checks the input power in the sensor module

Limit value: $>8 \text{ mW}$

"Measurement energy consumption" parameter

Checks whether the energy consumption of the sensor module is in the valid range

Limit value: 1 to 20 mWs

Sensor module voltage

Checks the supply voltages.

"Value for power supply 1.8 V" parameter

Supply voltage for the logic part of the sensor module (processor, memory)

Limit value: 1.71 to 1.95 V

"Value for DCS power supply" parameter

Supply voltage transmitted by the mainboard to the sensor module

Limit value: 6 to 20 V

RAM check

Checks the correct function of the RAM (Random Access Memory). If a RAM cell is defective, this is detected by the value read back from the RAM cell and **Failed** is displayed.

ROM check

Checks the correct function of the ROM memory (Read-Only-Memory). If the checksum of the tested program code range does not match, **Failed** is output.

4.6 Other Verification information



The following parameters are information values only and do not include an evaluation with respect to **Passed/Failed**.

4.6.1 Process conditions at the time of verification

"Signal quality" parameter

Possible causes of poor signal quality are EMC interference, a defective device on the same bus, poor contacts, an incorrectly dimensioned resistor

EMC interference

"Electronics temperature" parameter

Current Electronics temperature and permitted Minimum/maximum values

"Sensor temperature" parameter

Current Sensor temperature and permitted Minimum/maximum values

"Level linearized" parameter

Displays linearized level

"Absolute echo amplitude" parameter

Shows the absolute amplitude of the evaluated level signal.

"Relative echo amplitude" parameter

Shows the relative amplitude (i.e. the distance to the evaluation curve) of the evaluated level signal.

4.6.2 Device history**Terminal voltage value**

Shows the current terminal voltage that is applied at the output. Including the Minimum/maximum values achieved since the last reset.

Electronics temperature

Displays the current temperature of the main electronics. Including the Minimum/maximum values achieved since the last reset.

"Sensor temperature" parameter

Displays the current temperature of the sensor electronics. Including the Minimum/maximum values achieved since the last reset.

"Time min. sensor temperature" parameter

Time of the operating time counter at which the Minimum sensor temperature was reached

"Time max. sensor temperature" parameter

Time of the operating time counter at which the Maximum sensor temperature was reached

4.6.3 Sensor history**"Max. filling speed" parameter**

Shows the maximum Filling speed achieved since the last reset; used to detect possible measurement peaks

"Max. draining speed" parameter

Shows the maximum Draining speed achieved since the last reset; used to detect possible measurement peaks

"Level linearized" parameter

Displays the linearized level. Including the Minimum/maximum values achieved since the last reset.

"Time min. level" parameter

Time of the operating time counter at which the Min. level value was reached. Helps assign the recorded measurement peak to the process sequence

"Time max. level" parameter

Time of the operating time counter at which the Max. level value was reached. Helps assign the recorded measurement peak to the process sequence

"Counter underfilling" parameter

Number of level undershoots less than 0%

"Counter overfilling" parameter

Number of level overshoots greater than 100%

"Switch-on operations" parameter

Number of switch-on operations of the device

4.7 Safety mode wizard



The device can be write-protected via the software using this wizard. The safety-related parameters must be confirmed in the wizard.

1. In the preparation screen, enter the locking code "7452".
2. Go through the wizard step by step.
3. Enter "7452" as the locking code.

The current **CRC device configuration** parameter is saved at the end of the wizard and the device is locked. The **CRC device configuration** parameter is unique and is built based on the current settings of safety relevant parameters.

If a device is unlocked and locked again, the current **CRC device configuration** parameter is compared with the **Stored CRC device configuration** parameter. If there is no difference in the configuration, the device is locked immediately. If there is a difference in the configuration, the safety-related parameter settings must be confirmed again.

4.8 Heartbeat Technology in safety instrumented systems

Verification (Heartbeat Verification) enables the documentation of the current device diagnostic or device status as a proof of testing.

- This supports the documentation of proof tests in accordance with IEC 61511-1, Section 16.3.3, "Documentation of proof tests and inspection".
- The verification is based on automatically executed device-specific test sequences. From a safety point of view, verification cannot replace the proof-testing of a sensor, since random errors are usually not detected.
- Nevertheless, verification can be usefully applied as a step in a proof-test scenario as per NA 106 as a flexible proof-testing strategy.
- The verification report should be regarded as a supplement to the proof-test report.



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